

DR. A.P.J. ABDUL KALAM TECHNICAL
UNIVERSITY, UTTAR PRADESH, LUCKNOW



EVALUATION SCHEME & SYLLABUS

FOR

B. TECH. THIRD YEAR

**Electronics and Communication
(Advanced Communication Technology)**

AS PER

AICTE MODEL CURRICULUM & NEP2020

[Effective from the Session: 2025-26]

ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech. V Semester

Electronics and Communication (Advanced Communication Technology)

S. No.	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit
					L	T	P	CT	TA				
1	BEC501	Integrated Circuits	T	PC	3	1	0	20	10	30	70	100	4
2	BEC502	Microprocessor & Microcontroller	T	PC	3	1	0	20	10	30	70	100	4
3	BEC503	Digital Signal Processing	T	PC	3	1	0	20	10	30	70	100	4
4	----	Department Elective-I	T	PC	3	0	0	20	10	30	70	100	3
5	----	Department Elective-II	T	PC	3	0	0	20	10	30	70	100	3
6	BEC551	Integrated Circuits Lab	P	PC	0	0	2		50	50	50	100	1
7	BEC552	Microprocessor & Microcontroller Lab	P	PC	0	0	2		50	50	50	100	1
8	BEC553	Digital Signal Processing Lab	P	PC	0	0	2		50	50	50	100	1
9	BEC-554	Mini Project/Internship **	P	PC	0	0	2		50	50		50	1
10	BNC501 / BNC502	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	T	VA	2	0	0	20	10	30	70	100	NC
		Total										850	22
**The Mini Project or Internship (4weeks) conducted during summer break after IV Semester and will be assessed during Vth Semester.													

Course Code

Course Title

Department Elective-I

BEC-051	IoT – Architecture, Communication, Technology & its applications
BEC-053	Intelligent Systems and Robotics
BAC-051	Adaptive Signal Processing
BAC-052	Remote Sensing and Applications

Department Elective-II

BEC-055	Electronics Switching
BEC-057	Optical Communication
BAC-053	Radar and Satellite Communication
BAC-054	CDMA and OFDM for multiuser communication

ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech. VI Semester

Electronics and Communication (Advanced Communication Technology)

S. No.	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit
					L	T	P	CT	TA				
1	BEC601	Digital Communication	T	PC	3	1	0	20	10	30	70	100	4
2	BEC602	Control System	T	PC	3	1	0	20	10	30	70	100	4
3	BEC603	Antenna and Wave Propagation	T	PC	3	1	0	20	10	30	70	100	4
4	----	Department Elective–III	T	PC	3	0	0	20	10	30	70	100	3
5		Open Elective-I	T	PC	3	0	0	20	10	30	70	100	3
6	BEC651	Digital Communication Lab	P	PC	0	0	2		50	50	50	100	1
7	BEC652	Control System Lab	P	PC	0	0	2		50	50	50	100	1
8	---	Elective Lab	P	PC	0	0	2		50	50	50	100	1
9	BNC601 / BNC602	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	T	VA	2	0	0	20	10	30	70	100	NC
		Total										800	21

Course Code

Course Title

Department Elective-III

BAC-061	Wireless Communications Networks
BAC-062	Information Theory & Coding
BEC-062	Data Communication Networks
BEC-064	Microcontrollers and Sensors for IoT Applications

Course Code

Elective Lab

BAC-653A	Wireless Communications Networks Lab
BEC-653B	CAD (Computer-Aided Design) for Electronics Lab
BEC-653C	Microcontrollers and Sensors for IoT Applications Lab

**B.Tech 3rd Year
V Semester
Syllabus**

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC -501	INTEGRATED CIRCUITS	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	The 741 IC Op-Amp: General operational amplifier stages (bias circuit, the input stage, the second stage, the output stage, short circuit protection circuitry), device parameters, DC and AC analysis of input stage, second stage and output stage, gain, frequency response of 741, a simplified model, slew rate, relationship between f_t and slew rate.	8
II	Linear Applications of IC Op-Amps: Op-Amp based V-I and I-V converters, instrumentation amplifier, generalized impedance converter, simulation of inductors. Active Analog filters: Sallen Key second order filter, Designing of second order lowpass and high pass Butterworth filter, Introduction to band pass and band stop filter, all pass active filters, KHN Filters. Introduction to design of higher order filters.	8
III	Frequency Compensation & Nonlinearity: Frequency Compensation, Compensation of two stage Op-Amps, Slewing in two stage Op-Amp. Nonlinearity of Differential Circuits, Effect of Negative feedback on Nonlinearity. Non-Linear Applications of IC Op-Amps: Basic Log–Anti Log amplifiers using diode and BJT, temperature compensated Log-Anti Log amplifiers using diode, peak detectors, sample and hold circuits. Op-amp as a comparator and zero crossing detector, astable multivibrator & monostable multivibrator. Generation of triangular waveforms, analog multipliers and their applications.	4 8
IV	Digital Integrated Circuit Design: An overview, CMOS logic gate circuit's basic structure, CMOS realization of inverters, AND, OR, NAND and NOR gates. Latches and Flip flops: the latch, CMOS implementation of SR flip-flops, a simpler CMOS implementation of the clocked SR flip-flop, CMOS implementation of J-K flip- flops, D flip-flop circuits.	6
V	Integrated Circuit Timer: Timer IC 555 pin and functional block diagram, Monostable and Astable multivibrator using the 555 IC. Voltage Controlled Oscillator: VCO IC 566 pin and functional block diagram and applications. Phase Locked Loop (PLL): Basic principle of PLL, block diagram, working, Ex-OR gates and multipliers as phase detectors, applications of PLL.	6

Text Book:

1. Microelectronic Circuits, Sedra and Smith, 7th Edition, Oxford, 2017.
2. Behzad Razavi: Design of Analog CMOS Integrated Circuits, TMH

Reference Books:

1. Gayakwad: Op-Amps and Linear Integrated Circuits, 4th Edition Prentice Hall of India, 2002.
2. Franco, Analog Circuit Design: Discrete & Integrated, TMH, 1st Edition.
3. Salivahnan, Electronics Devices and Circuits, TMH, 3rd Edition, 2015
4. Millman and Halkias: Integrated Electronics, TMH, 2nd Edition, 2010

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Explain complete internal analysis of Op-Amp 741-IC.
2. Examine and design Op-Amp based circuits and basic components of ICs such as various types of filters.
3. Implement the concept of Op-Amp to design Op-Amp based non-linear applications and wave-shaping circuits.
4. Analyse and design basic digital IC circuits using CMOS technology.
5. Describe the functioning of application specific ICs such as 555 timer, VCO IC 566 and PLL.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-502	MICROPROCESSOR & MICROCONTROLLER	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	Introduction to Microprocessor: Microprocessor architecture and its operations, Memory, Input & output devices, The 8085 MPU- architecture, Pins and signals, Timing Diagrams, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O.	8
II	Basic Programming concepts: Flow chart symbols, Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, writing assembly language programs, Programming techniques: looping, counting and indexing. Additional data transfer and 16-bit arithmetic instruction, Logic operation: rotate, compare, counter and time delays, 8085 Interrupts.	8
III	16-bit Microprocessors (8086): Architecture, Pin Description, Physical address, segmentation, memory organization, Addressing modes. Peripheral Devices: 8237 DMA Controller, 8255 programmable peripheral interface, 8253/8254 programmable timer/counter, 8259 programmable interrupt controller, 8251 USART and RS232C.	8
IV	8051 Microcontroller Basics: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing with External ROM And RAM. 8051 Addressing Modes.	8
V	Assembly programming and instruction of 8051: Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. Programming 8051 Timers. Serial Port Programming, Interrupts Programming, Interfacing: LCD & Keyboard Interfacing, ADC, DAC & Sensor Interfacing, External Memory Interface, Stepper Motor and Waveform generation.	8

Text Books:

1. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 6th Edition, Penram International Publication (India) Pvt. Ltd., 2013
2. D. V. Hall: Microprocessors Interfacing, TMH 3rd Edition,
3. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D., "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson, 2nd Edition, 2006

Reference Books:

1. Kenneth L. Short, "Microprocessors and programmed Logic", 2nd Ed, Pearson Education Inc., 2003
2. Barry B. Brey, "The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium-Pro Processor, Pentium-II, Pentium-III, Pentium-IV, Architecture, Programming & Interfacing", Eighth Edition, Pearson Prentice Hall, 2009.
3. Shah Satish, "8051 Microcontrollers MCS 51 Family and its variants", Oxford, 2010

Course Outcomes: At the end of this course students will demonstrate the ability to

1. Demonstrate the basic architecture of 8085.
2. Illustrate the programming model of microprocessors & write program using 8085 microprocessors.
3. Demonstrate the basics of 8086 Microprocessor and interface different external Peripheral Devices like timer, USART etc. with Microprocessor (8085/8086).
4. Compare Microprocessors & Microcontrollers, and comprehend the architecture of 8051 microcontroller.
5. Illustrate the programming model of 8051 and implement them to design projects on real time problems.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-503	DIGITAL SIGNAL PROCESSING	3L:1T:0P	4 Credits
Unit	Topics	Lectures	
I	Introduction to Digital Signal Processing: Basic elements of digital signal processing, advantages and disadvantages of digital signal processing, Technology used for DSP. Realization of Digital Systems: Introduction- basic building blocks to represent a digital system, recursive and non-recursive systems, basic structures of a digital system: Canonic and Non-Canonic structures. IIR Filter Realization: Direct form, cascade realization, parallel form realization, Ladder structures- continued fraction expansion of $H(z)$, example of continued fraction, realization of a ladder structure, design examples. FIR Filter Realization: Direct, Cascade, FIR Linear Phase Realization and design examples.	8	
II	Infinite Impulse Response Digital (IIR) Filter Design: Introduction to Filters, Impulse Invariant Transformation, Bi-Linear Transformation, All- Pole Analog Filters: Butterworth and Chebyshev, Design of Digital Butterworth and Chebyshev Filters, Frequency Transformations.	8	
III	Finite Impulse Response Filter (FIR) Design: Windowing and the Rectangular Window, Gibb's phenomenon, Other Commonly Used Windows (Hamming, Hanning, Bartlett, Blackmann, Kaiser), Examples of Filter Designs Using Windows. Finite Word length effects in digital filters: Coefficient quantization error, Quantization noise – truncation and rounding, Limit cycle oscillations-dead band effects.	8	
IV	DFT & FFT: Definitions, Properties of the DFT, Circular Convolution, Linear Convolution using Circular Convolution, Decimation in Time (DIT) Algorithm, Decimation in Frequency (DIF) Algorithm.	8	
V	Multirate Digital Signal Processing (MDSP): Introduction, Decimation, Interpolation, Sampling rate conversion: Single and Multistage, applications of MDSP- Sub-band Coding of Speech signals, Quadrature mirror filters, Advantages of MDSP.	8	

Text Books:

1. John G Prokias, Dimitris G Manolakis, Digital Signal Processing. Pearson, 4th Edition, 2007
2. Johnny R. Johnson, Digital Signal Processing, PHI Learning Pvt Ltd., 2009.
3. S. Salivahanan, A. Vallavaraj, Digital Signal Processing, TMH, 4th Edition 2017.

Reference Books:

1. Oppenheim & Schaffer, Digital Signal Processing. Pearson Education 2015
2. S.K. Mitra, 'Digital Signal Processing–A Computer Based Approach, TMH, 4th Edition.
3. Digital Signal Processing-a computer-based approach by S. K. Mitra, McGraw Hill.
4. Digital Signal Processing by A. Anand kumar, PHI learning PVT. Ltd.
5. Digital Signal Processing - a modern introduction by Ashok Ambardar, Cengage learning.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Design and describe different types of realizations of digital systems (IIR and FIR) and their utilities.
2. Select design parameters of analog IIR digital filters (Butterworth and Chebyshev filters) and implement various methods such as impulse invariant transformation and bilinear transformation of conversion of analog to digital filters.
3. Design FIR filter using various types of window functions.
4. Define the principle of discrete Fourier transform & its various properties and concept of circular and linear convolution. Also, students will be able to define and implement FFT i.e. a fast computation method of DFT.
5. Define the concept of decimation and interpolation. Also, they will be able to implement it in various practical applications.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-051	IoT – ARCHITECTURE, COMMUNICATION, TECHNOLOGY & ITS APPLICATIONS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Introduction to IoTs: Understanding IoT's fundamentals and Significance, Definition and Characteristics of IoT, Elements of an IoT ecosystem, Sensors, Actuators, Data Management, Overview of Governance, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization.	8
II	IoT Architecture: Software defined networks, Network function virtualization, Difference between SDN and NFV for IoT, IoT Open-source architecture (OIC) - OIC Architecture & Design principles, IoT Devices and deployment models - IoTivity: An Open Source IoT stack, Overview - IoTivity stack architecture, Resource model and Abstraction.	8
III	IoT Communication Protocols: Protocol Standardization for IoT, M2M and WSN Protocols, Issues with IoT Standardization, SCADA and RFID Protocols, Unified Data Standards – Protocols, Short, Medium and Long-Range Wireless Connectivity, Wired Connectivity, IOT Networking – Networking Architecture, Networking Protocols, IoT Devices Application-Level Protocols.	8
IV	Interfacing With Physical Devices: Introduction to Arduino and Raspberry Pi- Installation, Interfaces (Serial, SPI, I2C), Introduction to the Arduino environment, the Arduino board, the Arduino IDE, and the Arduino compatible shields together with their libraries. Interfacing Hardware with the Raspberry Pi, Raspberry Pi Remote Access, Communication with devices through the pins of the Raspberry Pi, Range of sensors interfacing such as voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors and others.	8
V	IoT Applications: Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.	8

Text Books:

1. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, November 2013, John Wiley and Sons.
2. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and Sons.
3. Simon Monk, “Programming the Raspberry Pi: Getting Started with Python”, January 2012, McGraw Hill Professional.

Reference Books:

1. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.
2. Dr. Ovidiu Vermesan, Dr. Peter Friess “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers.
3. Donald Norris, “The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone Black”, McGraw Hill, 2015.
4. Eben Upton and Gareth Halfacree, “Raspberry Pi User Guide”, August 2016, 4th edition, John Wiley & Sons

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the fundamentals of IoT's.
2. Understand the vision of IoT's from a global context.
3. Building State of the art architecture in IoT.
4. Interface mechanism of different Sensors, Gateways, and other external Devices with microcontroller board
5. Application of IoT in Industrial and Commercial Building Automation.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC -053	INTELLIGENT SYSTEMS AND ROBOTICS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	System Modeling: Biological and Cognitive Paradigms for Robot Design, Declarative-Procedural-Reflexive Hierarchy for Decision-Making and Control, Articulated Robots, Joint-Link (Denavit - Hartenberg) Transformations, Mobile Ground Robots, Uninhabited Air Vehicles, Intelligent Agents.	8
II	Control System Principles: Open- and Closed-Loop Control, Time-domain and Frequency-domain Analysis, Optimality and Constraints, Stability and Performance, Adaptation, Control Actuation, Closed-form and Probabilistic Path Planning.	8
III	Computing, Measurement, State, and Parameter Estimation: Sensors and Sensing, Formal and Fuzzy Logic, Turing Machines and Concepts of Machine Learning, Analog and Digital Systems, Probability and Error Models, Sensor-Based Estimation, Extended Kalman and Particle Filters, Simultaneous Location and Mapping (SAM).	8
IV	Decision-Making and Machine Learning: Decision Trees, Bayesian Belief Networks, Classification of Data Sets, Task Planning for Individual and Multiple Agents.	8
V	Numerical Methods for Evaluation and Search: Monte Carlo Simulation, Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Production Systems, Forward Chaining, Backward Chaining, Training and Implementation of Network Architectures, Feed-Forward Networks, Associative Networks, Cerebellar Model Articulation Controller, Deep-Learning Algorithms.	8

Text Books:

1. H. Asada and J.-J. Slotine, Robot Analysis and Control, J. Wiley & Sons, 1986.
2. C. Asfahl, Robots and Manufacturing Automation, J. Wiley & Sons, 1992.
3. D. Auslander, J. Ridgely, and J. Ringgenberg, Control Software for Mechanical Systems, Prentice-Hall, 2002.
4. G. Bekey, Autonomous Robots, MIT Press, 2005.
5. Albus, J. I., and Meystel, A. M., Engineering of Mind, J. Wiley & Sons, 2001.
6. P. Antsaklis and K. Passino, An Introduction to Intelligent and Autonomous Control, Kluwer, 1993.

Reference Books:

1. J. Craig, Introduction to Robotics Mechanics and Control, Pearson, 2018
2. R. Dorf, Robotics and Automated Manufacturing, Reston (Prentice-Hall), 1983
3. D. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Apply the concept of Open- and Closed-Loop Control.
2. Apply Fourier to understand Time-domain and Frequency-domain Analysis
3. Apply the fundamental concepts of Closed-form and Probabilistic Path Planning
4. Analyze Formal and Fuzzy Logic.
5. Analyze Simultaneous Location and Mapping (SAM).

ELECTRONICS AND COMMUNICATION ENGINEERING

BAC-051	ADAPTIVE SIGNAL PROCESSING	3L:0T:0P	3 Credits
Unit	Topics	Lectures	
I	Digital Processing of Continuous-Time Signals: Sampling of low pass continuous-time signals; Bandpass Sampling, Aliasing, reconstruction of sampled signal. Anti-aliasing filter characteristics, Physical reliability of systems, analog to discrete signal representations.	6	
II	IIR filter design by approximation of derivatives, Inverse Chebyshev filter, Elliptic filters. Overview of FIR filter design using window function.	6	
III	Multirate digital signal processing, Basic structures for sampling rate conversion, Decimators, and Interpolators; Multistage design of interpolators and decimators; Polyphase decomposition and FIR structures;	6	
IV	Filtering Problems, Adaptive filters, Linear Filter Structures: Transversal Filter. Introduction of Adaptive filtering algorithms: LMS Algorithm, RLS Algorithm.	6	
V	Go Programming Concepts: Module 1 - Getting Started: Go Runtime and Compilations, Keywords and Identifiers, Constants and Variables, Operators and Expressions, Local Assignments, Booleans, Numerics, Characters, Pointers and Addresses, Strings Module 2 – Constructs: if-else and switch, for Statements, Counter-controlled Iterations, Condition-controlled Iterations, Range Loops, using break and continue Module 3 – Functions: Parameters and Return Values, Call by Value and Reference, Named Return Variables, Blank Identifiers, Variable Argument Parameters, Using defer statements, Recursive Functions, Functions as Parameters, Closures Module 4 - Working with Data: Array Literals, Multidimensional Arrays, Array Parameters, Slices and Slice Parameters, Multidimensional Slices, Reslicing, Maps and Map Parameters, Map Slices, Structures and Structure Parameters, Structure Tags and Fields, Embedded Structures, Recursive Structures Module 5 - Methods and Interfaces: Method Declarations, Functions vs. Methods, Pointer and Value Receivers, Method Values and Expressions, Interface Types and Values, Type Assertions and Type Switches, Method Sets with Interfaces, Embedded Interfaces, Empty Interfaces, Working with Interfaces Module 6 - Goroutines and Channels: Concurrency vs. Parallelism, Goroutine Functions and Lambdas, Wait Groups, Channels, Sending and Receiving, Unbuffered and Buffered Channels, Directional Channels, Multiplexing with select, Timers and Tickers Module 7 - Packages and Testing: Packages and Workspaces, Exporting Package Names, Import Paths and Named Imports, Package Initializations, Blank Imports, Unit Testing with Test Functions, Table Tests and Random Tests, Benchmarking Module 8 - Working with Go: Files and Directories, Reading Directories, Reading Files, Writing Files, Copying Files, Error Strategies, Panic and Recover, Package Error Handling, Regular Expressions	16	

Textbooks

1. "Digital Signal Processing, 4th Edition" by Proakis and Manolakis, Prentice Hall, 2007 (ISBN: 0-13-187374-1).
2. Vetterli, J. Kovacevic, and V. K. Goyal, "Foundation of Signal Processing", Cambridge University Press, 2014

Reference Books

1. Rabiner & Gold, "Theory & application of digital Signal Processing", PHI 1992.
2. Roman kuc, "Introduction to Digital Signal Processing," McGraw hill Edition.
3. Openheim AV & Schafer RW, "Discrete Time Signal Processing" PHI.
4. Fredric J Harris, "Multirate Signal Processing for Communication Systems", ISBN: 9788770222105, River Publishers Series in Signal, Image and Speech Processing.

Course Outcomes: At the end of this course students will be able to:

1. Apply the Signal processing in the conversion of analog to discrete signals.
2. Apply mathematical tools to real-world signal processing.
3. Analyze the sampling rate conversion methodologies.
4. Apply the fundamental knowledge of adaptive filtration for signal processing.

ELECTRONICS AND COMMUNICATION ENGINEERING

BAC 052	REMOTE SENSING AND APPLICATIONS	3L:0T:0P	3 Credits
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Unit	Topic	Lectures
I	Satellite Communication and Remote Sensing Applications Introduction to Satellite Communication includes types of satellites such as geostationary and polar-orbiting, orbit selection and coverage, data transmission and reception, and the role of ground stations for remote sensing.	8
II	Applications & Methods of Satellite Remote Sensing: Agriculture, crop monitoring, urban planning, Defence applications, health and medical uses, disaster management and climate studies for atmospheric research and forecasting. Various Methods of Data acquisition for remote sensing.	8
III	Camera Technologies for Satellite Remote Sensing: Camera resolution, type of resolution, image bandwidth, Image data volume, size of the optic, aperture for light revelation, field of view (FOV), radiometric resolution, pixel pitch, focal length, types of lenses, and optical payloads for satellite imagery, brief study of camera sensors used in the satellite payload available in literature.	8
IV	Image Processing and Interpretation in Remote Sensing Basics of Digital Image Processing, Preprocessing Techniques (Radiometric and Geometric Corrections), Image Enhancement and Classification (Supervised & Unsupervised), Introduction to GIS (Geographic Information System)	8
V	Emerging Trends and Practical Applications of Remote Sensing Hands-on Project: Analysing Satellite Images Using Open-Source Tools (QGIS, Google Earth Engine) Case Studies: Identifying Land Use, Vegetation Mapping, and Climate Monitoring using NOAA/ Landsat etc.	8

Text Books:

1. Remote Sensing and Image Interpretation, 7^{ed} (An Indian Adaptation), Thomas Lillesand, Ralph W. Kiefer, Dr. P. K. Champati Ray, Wiley, 2022
2. Principle of Remote Sensing, Wim H. Bakker, et al., ITC Educational Textbooks, 2001

Reference Books:

1. Space Optical Remote Sensing, Jiasheng Tao, Springer, 2023.
2. Introduction to Remote Sensing, Sixth Edition, James B. Campbell, Randolph H. Wynne, and Valerie A. Thomas, 2022

COURSE OUTCOME: After completion of the course student will be able to:

1. Explain the fundamental principles and applications of remote sensing in engineering contexts.
2. Demonstrate proficiency in applying image processing techniques to interpret remote sensing data.
3. Evaluate and select appropriate remote sensing systems for specific engineering challenges.
4. Design remote sensing systems tailored to meet specific engineering requirements.
5. Assess the impact of emerging trends in remote sensing technologies on engineering applications.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC -055	ELECTRONIC SWITCHING	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Evolution of switching systems: Introduction, Message switching, Circuits switching, Functions of a switching system, Register translator- senders, Distribution frames, Crossbar switch, A general trucking, Electronic switching, Reed- electronic system, Digital switching systems.	8
II	Digital Switching: Switching functions, Space Division Switching, Time Division Switching, Two-Dimensional Switching, Digital Cross- Connect Systems, Digital Switching in an Analog Environment.	8
III	Telecom Engineering: Network Traffic Load and Parameters, Grade of Service and Blocking Probability, Modeling Switching Systems, Incoming Traffic and Service Time Characterization, Blocking models and Loss Estimates, Delay Systems	8
IV	Control of switching systems: Introduction, Call-processing functions, Common control, Reliability, availability and security; Stored-program control. Signaling: Introduction, Customer line signaling, Audio- frequency junctions and trunk circuits, FDM carrier systems, PCM signaling, Inter-register signaling, Common-channel signaling principles, CCITT signaling system no. 6 and 7, Digital customer line signaling.	8
V	Packet Switching: Packet Switching, Statistical Multiplexing, Routing Control (dynamic routing, virtual circuit routing and fixed-path routing), Flow Control, X.25, Frame Relay, TCP/IP ATM Cells, ATM ServiceCategories, ATM Switching (ATM Memory Switch, Space-Memory Switch, Memory-Space Switch, Memory-Space Memory switch, Banyan Network Switch, Clos Networks).	8

Text Book:

1. Thiagarajan Viswanathan & Manav Bhatnagar, “Telecommunication Switching Systems and Networks”, PHI, 2018
2. J.E. Flood, “Telecommunication Switching, Traffic and Networks”, Pearson Education 2016.
3. John C. Bellamy, “Digital Telephony”, John Wiley, 3rd Ed, 2006

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Describe the fundamentals of circuit switching and distinguish complex telephone systems.
2. Differentiate the fundamentals of Space division switching and time division switching.
3. Design, develop and evaluate the telecom traffic to meet defined specifications and needs.
4. Identify the control of switching networks and signaling concepts.
5. Classify the engineering concepts of packet switching and routing which will help to design various switch architectures for future research work.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-057	OPTICAL COMMUNICATION	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Introduction to Optical Communication: Optical Spectral Band with Operating Windows, General Communication System, Optical Communication System with its advantages. Optical Fiber Waveguides: Ray Theory of Transmission with TIR, Acceptance Angle, Numerical Aperture and Skew Rays, Electromagnetic Mode Theory for Optical Propagation, Modes in a Planar Guide, Phase and Group Velocity, Phase Shift with Total Internal Reflection, Evanescent Field, Goos-Haenchen Shift, Cylindrical Fiber Modes, Mode Coupling, Step Index fibers Vs Graded Index fibers, Single Mode Fibers- Cut off wavelength, MFD & Spot Size.	8
II	Signal Loss in Optical Fibers: Attenuation, Material Absorption Losses (Intrinsic and Extrinsic absorption), types of Linear and Non-Linear Scattering Losses, Fiber Bending Losses, Kerr Effect. Dispersion: Introduction with its types: Chromatic / Intramodal Dispersion (Material and Waveguide Dispersion), Intermodal dispersion (for MSI and MGI fibers), Overall (Total) Fiber Dispersion in Multimode and Single Mode Fiber, Dispersion Modified Single Mode Fibers, Polarization & Fiber Birefringence.	8
III	Optical Sources: LEDs -Introduction to LEDs & Materials used for fabrication, LED Power and Efficiency, LED Structures, LED Characteristics, Modulation Bandwidth. Laser Diodes -Introduction, Optical Feedback & Laser Oscillations, Resonant Frequencies, Laser Modes, and Threshold Condition for Laser Oscillation, Laser Diode Rate Equations, Semiconductor injection Laser- Efficiency, Laser Single Mode operation, Reliability of LED & ILD.	8
IV	Power Launching in Fiber: Source to Fiber Power Launching and Coupling Techniques, Power Launching Vs Wavelength, Equilibrium Numerical Aperture. Photo Detectors: Introduction, Physical Principles of Photodiodes: The PIN PhotoDetector, Avalanche Photodiodes, Temperature Effect on Avalanche Gain, Detector Response Time, Photo Detector Noise: Noise Sources, Signal to Noise Ratio, Comparison of Photo Detectors, Fundamental Receiver Operation with Digital Signal Transmission.	8
V	Digital Receiver Performance: Probability of Error / BER, Receiver Sensitivity & The Quantum Limit, Error Control Techniques, Eye Diagram Pattern Features, Coherent Detection: Homodyne Detection and Heterodyne Detection, Digital links: Point to Point Links, Power Penalties, Multichannel & Multiplexing Transmission Techniques, basic concept of Free Space Optics (FSO) based Communication System.	8

Text Book:

1. John M. Senior, "Optical Fiber Communications", Pearson, 3rd Edition, 2010.
2. Gerd Keiser, "Optical Fiber Communications", McGraw Hill, 5th Edition, 2013.
3. Govind P. Agrawal, "Fiber Optic Communication Systems", John Wiley, 3rd Edition, 2004.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Define and explain the basic concepts and theory of optical communication.
2. Describe the signal losses with their computation and dispersion mechanism occurring inside the optical fiber cable.
3. Differentiate the optical sources used in optical communication with their comparative study.
4. Identify different optical components on receiver side; assemble them to solve real world problems related to optical communication systems.
5. Evaluate the performance of an optical receiver to get idea about power budget and ultimately be an engineer with adequate knowledge in optical domain.

ELECTRONICS AND COMMUNICATION ENGINEERING

BAC-053	RADAR AND SATELLITE COMMUNICATION	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Introduction to Radar Systems: Analog vs. digital modulation methods, Fundamentals of radar, radar equation and parameters, types of radars and applications, basic concepts of radar signal processing, principles of Synthetic Aperture Radar (SAR), Orbital Mechanics relevant to Radar Satellites, Introduction to Small satellites and CubeSats & their bandwidth requirements, Key components of satellite systems	8
II	Radar Components and Signal Processing: Overview of radar transmitters and receivers, Understanding the radar range equation, Antenna types and their radiation patterns, Basics of radar signal processing, Analysing radar signal characteristics using Software Defined Radio	8
III	Introduction to Satellite Communication: Evolution and applications of satellite communication, Satellite orbits: Geostationary and non-geostationary, Overview of modern satellite services (e.g., GPS, remote sensing), Concepts of GPS, GLONASS, and BEIDOU, and NAVIC.	8
IV	Satellite Communication Link Design: Understanding uplink and downlink frequencies, Concept of link budget and its significance, Factors affecting signal propagation, communication links setup using the satellite trainer kit and software-defined radio for weather forecast.	8
V	Emerging Trends and Practical Applications: Ethical and regulatory considerations in satellite communication, Deployment and impact of Low Earth Orbit (LEO) satellite constellations, Development of Next Generation Networks and its convergence with satellite networks, Emergence of satellite-based Internet of Things (IoT) connectivity	8

Text Books:

1. Introduction To Radar Systems (II International Edition), Merrill I. Skolnik, McGraw-Hill, Inc, ISBN 0-07-057909-1
2. Introduction To Satellite Communication (III International Communication), ARTEC House Boston, ISBN-13: 978-1-59693-210-4

Reference Books:

1. Satellite Communications Systems Engineering Atmospheric Effects, Satellite Link Design and System Performance, Louis J. Ippolito, Jr. USA, WILEY
2. Understanding GPS/GNSS: Principles and Applications, Third Edition, Elliott D. Kaplan, Christopher Hegarty, ISBN: 9781630810580, ARTEC House, 2017

Course Outcomes: At the end of this course students will able to

1. Explain the principles of radar and satellite communication systems.
2. Demonstrate practical skills in communication system analysis and implementation.
3. Evaluate radar and satellite communication link performance.
4. Apply concepts to design and implement radar and satellite communication solutions.
5. Analyze emerging trends and ethical considerations in satellite communication.

ELECTRONICS AND COMMUNICATION ENGINEERING

BAC-054	CDMA AND OFDM FOR MULTIUSER COMMUNICATION	3L:0T:0P	3 CREDITS
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Unit	Topics	Lectures
I	Fundamentals of OFDM: Principles of QAM-OFDM-Modulation by DFT-Transmission via bandlimited channels, Generalized Nyquist Criterion-Basic OFDM Implementations-Cyclic OFDM Symbol Extension, OFDM Bandwidth Efficiency-Choice of the OFDM Modulation. OFDM system performance over AWGN channels-OFDM transmission over UMTS type channel Inter-subcarrier Interference cancellation	8
II	OFDM Synchronization and Modulation: Performance with frequency and timing errors-Synchronization Algorithms-Synchronization using pilots. Motivations for Adaptive modulation -Adaptive techniques-channel quality estimation-parameter adaptation-Signaling the AOOFDM parameters. Multiuser AOOFDM-Adaptive transceiver architecture-Simulation results with perfect channel knowledge-Pilot-based channel parameter estimation.	8
III	Channel Estimation and Detection for Multiuser OFDM System: Channel Estimation: LS Error Decision-Directed Channel Estimation-Derivation of the LS Estimator, Frequency Domain Parallel Interference Cancellation Aided DDCE-The Recursive Channel Estimator. Detection Techniques: Linear Detection Techniques-Least-Squares error Detector-Minimum Mean Square Error Detector. Non-Linear Detection Techniques-Standard SIC, MSIC and its Derivatives, PIC Detection.	8
IV	Principles of Code Division Multiple Access: Spread spectrum technique – Direct sequence and frequency hopping spread spectrum communication system – PN codes and Walsh codes – Rake receiver – Capacity – Effects of loading, sectorization and voice activity – Power control – Hand off – Link structure – Forward link – Pilot, synchronization, paging and traffic channels – Reverse Link – access and traffic channel.	8
V	OFDM Vs MC-CDMA Systems: Amalgamating DS-CDMA and OFDM-Multicarrier CDMA-MC-CDMA Performance in Synchronous environments. Adaptive modulation for OFDM and MC-CDMA-System description - General model five mode AQAM-Seven-Mode Adaptive Star-QAM-Five mode APSK-Ten-mode AQAM.	8

Text Book:

1. L.Hanzo, M.Munster, B.J.Choi and T.Keller, “OFDM and MC-CDMA for Broadband Multi-User Communications, WLANs and Broadcasting”, John Wiley & Sons, 2003.
2. Rohling, Hermann (Editor), “OFDM Concepts for Future Communications”, Springer, 2011.

Reference Books:

1. Ahmad RS Bahai, Burton R.Saltzberg and Mustafa Erge, “Multicarrier Digital Communications: Theory and Applications of OFDM”, Springer Newyork, 2004.
2. Samuel C Yang, “CDMA RF System Engineering”, Artech House, 1998.
3. Richard Van Nee and Ramjee Prasad, “OFDM for wireless Multimedia Communication”, Artech House, 2000.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the fundamentals of OFDM.
2. Analyze the performance of OFDM with frequency/timing errors and Adaptive modulation.
3. Estimate the channel and understand detection techniques.
4. Understand the principle of CDMA.
5. Analyze the performance of OFDM & MC-CDMA.

BEC-551	INTEGRATED CIRCUITS LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Design the following using Op-Amp: (*Through Virtual Lab Link 1*)
 - a) A unity gain amplifier.
 - b) An inverting amplifier with a gain of “A”.
 - c) A non-inverting amplifier with a gain of “A”
2. Study and design Log and antilog amplifiers.
3. Voltage to current and current to voltage convertors.
4. Second order filters using operational amplifier for: (*Through Virtual Lab Link 1*)
 - a) Low pass filter of cutoff frequency 1 KHz.
 - b) High pass filter of frequency 12 KHz.
5. Realization of Band pass filter with unit gain of pass band from 1 KHz to 12 KHz.
6. Study and design voltage comparator and zero crossing detectors.
7. Function generator using operational amplifier (sine, triangular & square wave).
8. Design and construct astable multivibrator using IC 555 and
 - a) Plot the output waveform
 - b) Measure the frequency of oscillation (*Through Virtual Lab Link 2*)
9. Design and construct a monostable multivibrator using IC 555 and
 - a) Plot the output waveform
 - b) Measure the time delay (*Through Virtual Lab Link 2*)
10. Implement Schmitt Trigger Circuit using IC 555. (*Through Virtual Lab Link 2*)
11. Implement voltage-controlled oscillator using IC566 and plot the waveform. (*Through Virtual Lab Link 2*)
12. Study and design ramp generator using IC 566.

Virtual Lab Link:

1. <http://vlabs.iitkgp.ernet.in/be/exp17/index.html>
2. <http://hecoep.vlabs.ac.in/Experiment8/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab>

Available on: <http://www.vlab.co.in/broad-area-electronics-and-communications>

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Design different non-linear applications of operational amplifiers such as log, antilog amplifiers and voltage comparators.
2. Explain and design different linear applications of operational amplifiers such as filters.
3. Demonstrate the function of waveforms generator using op-Amp.
4. Construct multivibrator and oscillator circuits using IC555 and IC566 and perform measurements of frequency and time.
5. Design and practically demonstrate the applications based on IC555 and IC566.

BEC-552	MICROPROCESSOR & MICROCONTROLLER LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers. *(Through Virtual Lab Link).*
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers. *3.(Through Virtual Lab Link).*
4. To perform multiplication and division of two 8 bit numbers using 8085. *(Through Virtual LabLink).*
5. To find the largest and smallest number in an array of data using 8085 instruction set.
6. To write a program using 8086 to arrange an array of data in ascending and descending order. *7.(Through Virtual Lab Link).*
8. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8086 instruction set.
9. To convert given Hexadecimal number into its equivalent BCD number and vice versa using 8086 instruction set.
10. To interface 8253 programmable interval timer and verify the operation of 8253 in six different modes.
11. To write a program to initiate 8251 and to check the transmission and reception of character.
12. Serial communication between two 8085 through RS-232 C port.
13. Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
14. Write a program to generate 10 kHz square wave using 8051.
15. Write a program to show the use of INT0 and INT1 of 8051.
16. Write a program for temperature & to display on intelligent LCD display.

Virtual Lab Link: http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/explist.php

Available on: <http://www.vlab.co.in/broad-area-electronics-and-communications>

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Use techniques, skills, modern engineering tools, instrumentation and software/hardware appropriately to list and demonstrate arithmetic and logical operations on 8-bit data using microprocessor 8085.
2. Examine 8085 & 8086 microprocessor and its interfacing with peripheral devices.
3. State various conversion techniques using 8085 & 8086 and generate waveforms using 8085.
4. Implement programming concept of 8051 Microcontroller.
5. Design concepts to Interface peripheral devices with Microcontroller so as to design Microcontroller based projects.

BEC-553	DIGITAL SIGNAL PROCESSING LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Introduction to MATLAB and or Open Source Software, Scilab (Using Spoken Tutorial MOOCs).
2. Write a Program for the generation of basic signals such as unit impulse, unit step, ramp, exponential, sinusoidal and cosine.
3. Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.
4. Verify Blackman and Hamming windowing techniques.
5. Evaluate 4-point DFT of and IDFT of $x(n) = 1, 0 \leq n \leq 3; 0$ elsewhere.
6. Verify Linear convolution of two sequences using FFT
7. Verify Circular Convolution of two sequences using FFT.
8. To verify FFT as sample interpolator.
9. To implement Tone Generation.
10. To implement floating point arithmetic.
11. To study about DSP Processors and architecture of TMS320C6713 DSP processor.
12. **VIRTUAL Lab by NME-ICT available at: (*Through Virtual Lab*)**
 - a. Study of Discrete Fourier Transform (DFT) and its inverse.
 - b. Study of FIR filter design using window method: Lowpass and highpass filter.
 - c. Study of FIR filter design using window method: Bandpass and Bandstop filter.
 - d. Study of Infinite Impulse Response (IIR) filter.

Virtual Lab Link: <http://vlabs.iitkgp.ernet.in/dsp/index.html#>
<http://vlabs.iitkgp.ernet.in/dsp/>

Available on: <http://www.vlab.co.in/broad-area-electronics-and-communications>

Spoken Tutorial (MOOCs):

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (<http://spoken-tutorial.org/>)

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Create and visualize various discrete/digital signals using MATLAB/Scilab.
2. Implement and test the basic operations of Signal processing.
3. Examine and analyse the spectral parameters of window functions.
4. Design IIR and FIR filters for band pass, band stop, low pass and high pass filters.
5. Design the signal processing algorithms using MATLAB/Scilab.

**B.Tech 3rd Year
VI Semester
Syllabus**

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-601	DIGITAL COMMUNICATION	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	Random Variables: Concept of Probability, Random variables, Statistical averages, Random process, Power Spectral Density & Autocorrelation Function of Random Processes, Gaussian Random Process.	8
II	Digital Communication Basics: Introduction to Digital communication systems, PSD of Line Coding schemes, Pulse shaping, Scrambling, Eye diagram, Gram-Schmidt orthogonalization scheme.	8
III	Digital Modulation: Modulation and Demodulation of Digital modulation schemes-ASK, FSK, PSK, DPSK, QPSK. Constellation diagram, Introduction to M-ary communication.	8
IV	Digital Receiver: Optimum threshold detection, Concept of Matched Filters, BER analysis of BASK, BFSK, BPSK, Introduction of Spread spectrum communication (DS-SS, FH-SS).	8
V	Information Theory: Measure of information-information, entropy, mutual information, mutual entropy, Source encoding (Shannon-Fano, Huffman), Shannon's channel capacity theorem, Introduction to error correction and detection, Linear block codes, Cyclic codes (systematic, non-systematic), Convolution coding and decoding.	8

Text Books:

1. B.P. Lathi, "Modern Digital and Analog communication Systems", 4th Edition, Oxford University Press.
2. John G. Proakis, "Digital Communications", 5th Edition, TMH.
3. H. Taub, D L Schilling, Gautam Saha, "Principles of Communication", 4th Edition, TMH.
4. Singh & Saprue, Communication Systems, 3th Edition, TMH.

Reference Books:

1. Simon Haykin, "Communication Systems", 5th Edition, Wiley India.
2. (Schaum's Outline Series) H P HSU & D Mitra, "Analog and Digital Communications", TMH, 3rd Edition.

Course Outcomes: At the end of this course students will demonstrate the ability:

1. To formulate basic statistics involved in communication theory.
2. To demonstrate the concepts involved in digital communication.
3. To explain the concepts of digital modulation schemes.
4. To analyze the performance of digital communication systems.
5. To apply the concept of information theory in digital systems.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-602	CONTROL SYSTEM	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	Introduction to Control Systems: Basic Components of a control system, Feedback and its effect, types of feedback control systems. Block diagrams Reduction and signal flow graphs, Modeling of Physical systems: electrical networks, mechanical systems elements, free body diagram, analogous Systems, sensors and encoders in control systems, modeling of armature controlled and field controlled DC servomotor.	8
II	State-Variable Analysis: Introduction, vector matrix representation of state equation, state transition matrix, state-transition equation, relationship between state equations and high- order differential equations, relationship between state equations and transfer functions, Decomposition of transfer functions, Controllability and observability, Eigen Value and Eigen Vector, Diagonalization.	8
III	Time domain Analysis of Control Systems: Time response of continuous data systems, typical test signals for the time response of control systems, unit step response and time-domain specifications, time response of a first order system, transient response of a prototype second order system, Steady-State error, Static and dynamic error coefficients, error analysis for different types of systems.	8
IV	Stability of Linear Control Systems: Bounded-input bounded-output stability continuous data systems, zero-input and asymptotic stability of continuous data systems, Routh Hurwitz criterion, Root-Locus Technique: Introduction, Properties of the Root Loci, Design aspects of the Root Loci.	8
V	Frequency Domain Analysis: Resonant peak and Resonant frequency, Bandwidth of the prototype Second order system, effects of adding a zero to the forward path, effects of adding a pole to the forward path, polar plot, Nyquist stability criterion, stability analysis with the Bode plot, relative stability: gain margin and phase margin.	8

Text Book:

1. I. J. Nagrath & M. Gopal, "Control System Engineering", 6th Ed. New Age International Publishers, 2018
2. B.C. Kuo & Farid Golnaraghi, "Automatic Control Systems", 9th Edition, John Wiley India, 2008

Reference Books:

1. (Schaums Outlines Series) Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Control Systems", 3rd Edition, TMH, Special Indian Edition, 2010.
2. A. Anand Kumar, "Control Systems", Second Edition, PHI Learning private limited, 2014.
3. William A. Wolovich, "Automatic Control Systems", Oxford University Press, 2011.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Describe the basics of control systems along with different types of feedback and its effect. Additionally, they will also be able to explain the techniques such as block diagrams reduction, signal flow graph and modelling of various physical systems along with modelling of DC servomotor.
2. Explain the concept of state variables for the representation of LTI system.
3. Interpret the time domain response analysis for various types of inputs along with the time domain specifications.
4. Distinguish the concepts of absolute and relative stability for continuous data systems along with different methods.
5. Interpret the concept of frequency domain response analysis and their specifications.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-603	ANTENNA & WAVE PROPAGATION	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	Coordinate Systems and Transformation: Cartesian, Cylindrical, Spherical transformation. Vector calculus: Differential length, area and volume, line, surface and volume integrals, Del operator, Gradient, Divergence of a vector, Divergence theorem, Curl of a vector, Stokes's theorem, Laplacian of a scalar.	6
II	Electrostatic fields and Magnetostatic fields: Electric field intensity, Electric field due to charge distribution, Electric flux density, Gauss's Law- Maxwell's equation, Continuity equation and relaxation time, boundary conditions, Magneto-static fields, Ampere's circuit law, Maxwell's equation, magnetic scalar and vector potential, Magnetic boundary conditions, Maxwell's equation in final form.	10
III	Antenna fundamental and definitions: Introduction, Basic antenna parameters, Patterns, Beam area (or Beam solid angle) Ω_A , Radiation intensity, Beam efficiency, Directivity D and Gain G, Directivity and resolution, Antenna apertures, Effective height, The radio communication link, Fields from oscillating dipole, Single-to-noise ratio (SNR), Antenna temperature, Antenna impedance.	8
IV	Antenna Design: Electric dipoles, The short electric dipole, The fields of a short dipole, Radiation resistance of short electric dipole, Thin linear antenna, Radiation resistance of $\lambda/2$ antenna, Array of two driven $\lambda/2$ elements: Broadside case and end-fire case, Horizontal antennas above a plane ground, Vertical antennas above a plane ground, Yagi-Uda antenna design, Long-wire antennas, Folded dipole antennas.	8
V	Wave Propagation: Plane earth reflection, Space wave and surface wave. Space wave propagation: Introduction, Field strength relation, Effects of imperfect earth, Effects of curvature of earth. Sky wave propagation: Introduction structural, details of the ionosphere, Wave propagation mechanism, Refraction and reflection of sky waves by ionosphere, Ray path, Critical frequency, MUF, LUF, OF, Virtual height and skip distance, Relation between MUF and the skip distance, Multi-Hop propagation, Wave characteristics.	8

Text Books:

1. MNO Sadiku, "Elements of Electromagnetic", 7th Ed, Oxford University Press, 2018.
2. John D Kraus, Ronald J Marhefka and Ahmad S. Khan, "Antennas and Wave Propagation", 5th Edition, Tata McGraw Hill, 2017.
3. Das, Antennas and Wave Propagation, TMH 1st Edition.

Reference Books:

1. C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley, 2016.
2. WH Hayt and JA Buck, "Engineering Electromagnetic", 7th Edition TMH, 2013.
3. (Schaums Outlines Series) Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Engineering Electromagnetic", 3rd Edition, TMH, Special Indian Edition, 2010.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Identify different coordinate systems and their applications in electromagnetic field theory to establish a relation between any two systems using the vector calculus.
2. Explain the concept of static electric field, current and properties of conductors.
3. Express the basic concepts of ground, space, sky wave propagation mechanism.
4. Demonstrate the knowledge of antenna fundamentals and radiation mechanism of the antenna.
5. Analyze and design different types of basic antennas.

ELECTRONICS AND COMMUNICATION ENGINEERING

BAC-061	WIRELESS COMMUNICATIONS NETWORKS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	OSI Model, TCP/IP reference model, Understanding of Delay, Loss and Throughput, Networking Devices The Physical Layer: guided transmission media, wireless transmission, the public switched telephone networks, mobile telephone system. Data Link Layer- Design issues, error detection and correction, elementary data link protocols, sliding window protocols, example data link protocols – HDLC, PPP	8
II	Network Layer - Virtual and Datagram networks, IP protocol and addressing in the Internet the network layer in the internet (IPv4 and IPv6), Subnetting with IPs, Routing algorithms Transport Layer - Multiplexing and Demultiplexing, UDP, Principles of reliable data transfer, TCP, Congestion control, SIP protocol. Application Layer- Web and HTTP, E-mail, DNS, Socket programming with TCP and UDP. DNS, electronic mail, World Wide Web: architectural overview, dynamic web document and http. Application Layer Protocols, Network Security.	8
III	Introduction to 1G/2G/3G/4G Terminology: evolution of cellular systems requirements, goals, and vision of the next-generation wireless communication systems Fading, Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTE-A - Wireless Standards.	8
IV	Small cells: Past, present, and future trends of cellular networks coverage and capacity of small cell networks Interference management, D2D architecture Towards IoT Spectrum sharing. Multicarrier modulation, OFDM, diversity multiplexing trade-off, OFDM system, smart-antenna: beam forming, cognitive radio, software-defined radio, communication relays, spectrum sharing.	8
V	Contention-free multiple access schemes (FDMA TDMA, CDMA, SDMA, and Hybrid), contention-based multiple access schemes (ALOHA and CSMA), Waveforms, Variable subcarrier spacing, supported transmission numerologies. Design Challenges in Ad-hoc wireless networks, the concept of cross-layer design, security in wireless networks, energy-constrained networks, MANET and WSN.	8

Text Books:

1. Computer Networks- A Top-Down approach, Behrouz Forouzan, McGraw Hill
2. T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock, Millimeter Wave Wireless Communication., Pearson Education, 2015.
3. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.

Reference Books:

1. Computer Networks (4th edition), Andrew Tanenbaum, Prentice Hall
2. Vijay K Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint)

ELECTRONICS AND COMMUNICATION ENGINEERING

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and OSI Model.
2. Analyze and design the topological and routing strategies for an IP based networking infrastructure and explain the working knowledge of computer applications and Network Security.
3. Explain the functioning of wireless communication systems and the evolution of different wireless communication systems and standards.
4. Explain architecture and modulation technique used for wireless communication systems.
5. Analyze the multiple access techniques and evaluate the design challenges and security issues associated with Ad-hoc wireless networks.

ELECTRONICS AND COMMUNICATION ENGINEERING

BAC-062	INFORMATION THEORY & CODING	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Entropy: Entropy, Joint Entropy and Conditional Entropy, Relative Entropy and Mutual Information, Relationship Between Entropy and Mutual Information, Chain Rules for Entropy, Relative Entropy and Mutual Information, Jensen's Inequality and Its Consequences, Log Sum Inequality and Its Applications, Data-Processing Inequality, Fano's Inequality.	8
II	Asymptotic Equipartition Property: Asymptotic Equipartition Property Theorem. Consequences of the AEP: Data Compression, High-Probability Sets and the Typical Set Data Compression: Examples of Codes, Kraft Inequality, Optimal Codes, Bounds on the Optimal Code Length, Kraft Inequality for Uniquely Decodable Codes, Huffman Codes, Optimality of Huffman Codes, Shannon - Fano–Elias Coding.	8
III	Channel Capacity: Channel Capacity for Various Binary Channels, Symmetric Channels, Properties of Channel Capacity, Preview of Channel Coding Theorem, Jointly Typical Sequences, Channel Coding Theorem, Channel capacity Theorem.	8
IV	Block Codes: Introduction to block codes, Single-parity check codes, Product codes, Repetition codes, Hamming codes, Minimum distance of block codes, Soft decision decoding, Automatic-repeat-request schemes. Linear Block codes: Definition of linear Block Codes, Generator matrices, Standard array, Parity-check matrices, Error detection and correction.	8
V	Convolution codes: Encoding convolutional codes, Generator matrices for convolutional codes, Generator polynomials for convolutional codes, Graphical representation of convolutional codes, Viterbi Algorithm, Binary Cycle Codes, BCH codes. RS codes, Golay codes.	8

Text Books:

1. Bose, Information Theory, Coding and Cryptography, McGraw-Hill Education, 3rd Edition, (2016).
2. Joy A. Thomas, Thomas M. Cover, "Elements of information theory", Wiley-Interscience; 2nd edition (July 18, 2006).
3. S. Gravano, "Introduction to Error Control Codes" OUP Oxford (24 May 2001).
4. Robert B. Ash, "Information Theory", Dover Publications (November 1, 1990).
5. Todd k Moon, "Error Correction Coding: Mathematical Methods and Algorithms " Wiley, 2005.

Reference Books:

1. Simon Haykin, "Digital communication", John Wiley.
2. Ranjan Bose, "ITC and Cryptography", Tata McGraw-Hill.
3. Roberto Togneri, Christopher J.S deSilva, "Fundamentals of Information Theory and Coding Design", CRC Press.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Explain each block involved in digital communication thoroughly with applications.
2. Apply the knowledge of basic concepts of probability and entropies to analyze the behavior of a communication system.
3. Analyze the use of source coding and evaluating all the techniques of source coding.
4. Examine the significance of channel coding and evaluating all available techniques of channel coding and decoding with challenges.
5. Examine various error control coding techniques.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-062	DATA COMMUNICATION NETWORKS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Introduction to Networks & Data Communications: Goals and Applications of Networks, The Internet, Protocols & Standards, Layered Tasks, OSI reference Model, TCP / IP, Addressing, Line Coding Review.	8
II	Physical Layer: Transmission Media- Guided and unguided, Network Topology Design, Data Link Layer: Error detection and Correction, Framing, Flow and Error Control Protocols, Noiseless Channel and Noisy Channel Protocol, HDLC, Point-to-Point Protocol	8
III	Multiple Access: RANDOH, CDMA, CSMA/CD, CSMA/CA, Controlled Access, Channelization Wired LANs: IEEE Standards, Standard Ethernet, Fast Ethernet, Gigabit Ethernet, Wireless LAN IEEE 802.11, Bluetooth IEEE 802.16.	8
IV	Network Layer: Design Issues. Routing Algorithms. Congestion control Algorithms. Internetworking –TCP/IP, IP Packet, IPv4 and IPv6 Protocols, IPV4 Addresses, Connecting Devices, Virtual LAN IPV6 Addresses.	8
V	Transport Layer Protocol: UDP and TCP, ATM, Cryptography, NetworkSecurity, Session Layer-Design issues. Application Layer: File Transfer, Electronic mail, HTTP, WWW, SMTP, Cryptography, Network Security.	8

Text Books:

- a. B. A. Forouzan, “Data Communications and Networking”, 5th Edition, TMH, 2017.

Reference Books:

1. S. Tanenbaum, “Computer Networks”, 4th Edition, Pearson, 2013.
2. W. Stallings, “Data and Computer Communication”, 8th Edition, Pearson, 2007.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Identify the issues and challenges in the architecture of a network.
2. Analyze the services and features of various protocol layers in data layer.
3. Demonstrate the knowledge of multiple access to design a access technique for a particular application.
4. Realize protocols at different layers of a network hierarchy.
5. Recognize security issues in a network and various application of application layer.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-064	MICROCONTROLLERS AND SENSORS FOR IOT APPLICATIONS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Fundamentals of IOT: Introduction to IoT, IoT Design Methodology, Design Principles for Connected Devices: Cloud and Ambient Technology, Internet Communications overview, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing.	8
II	Data Acquisition with IOT Devices: Prototyping embedded devices: Sensors and Actuators, Electronics and Power Components, Working mechanism of range of sensors and data acquisition, Data processing and analysis, Wireless Data transmission, IoT Point to point communication technology, IoT Communication Patterns, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BLE,NFC, LORA, Li-Fi, Widi).	8
III	MSP430 Microcontrollers: Functional Block diagram, Addressing modes, Instruction Set, Examples, Reflections on the CPU and Instruction Set, DPR for M.Tech IoT and Sensor Systems 2022 19 Exceptions, Clock system. Development: Development Environment, Access to the Microcontroller for Programming and Debugging, Demonstration Boards, Examples. Functions, Interrupts, and Low-Power Modes. Functions and Subroutines, Interrupts, ISR, Low-Power Modes of Operation.	8
IV	Sensor Interfacing and Applications: Sensors interfacing: Sensors interfacing techniques-Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DHT11Cloud interfacing: Interfacing and data logging with cloud: Thing speak. IoT's Applications – Smart Farming: Smart Greenhouse, Drones for pesticides, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking, IoT for Healthcare, and weather analysis.	8
V	Security and Privacy in IoT: The problem- “Identity of Things”, Device On-Boarding, Symmetric Encryption Standards: Symmetric Encryption (DES, AES 128), Hashing, Authentication, CCMP Authentication and Encryption protocol, Non-Symmetric Encryption Standards: Diffie Hellman (principle, Man in the Middle attack), RSA, Digital Signature and Authentication.	8

Text Books:

1. A Beginner's Guide to Internet of Things Security: Attacks, Applications, B.B. Gupta, Aakansha Tiwari, CRC Press, Taylor and Francis Group, 2020.
2. Donald Norris, “The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black”, McGraw Hill, 2015.
3. John H. Davies, “MSP430 Microcontroller Basics”, 2011, 2nd ed., Newnes publishing, New York.

Reference Books:

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015.
2. A First Course in Fuzzy and Neural Control by Nguyen, Prasad, Walker, and Walker. CRC 2003.
3. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2014, 4th ed., Springer, New York.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Introduction to IoTs enabled technologies.
2. Analyze the mechanism of Data Acquisition and processing.
3. Understand data classification, process of big data technology, user roles and Detects myths in big data
4. Analyze software and management tools for Industrial applications of IoTs
5. Understand the Real-World design constraints and challenges.

BEC-651	DIGITAL COMMUNICATION LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

Part A

1. To study Eye diagram patterns of various digital pulses.
2. To study the inter symbol interference.
3. To study generation of Unipolar RZ & NRZ Line Coding.
4. To study generation of Polar RZ & NRZ Line Coding.
5. To study generation of Bipolar RZ & NRZ Line Coding.
6. Implementation and analysis of BASK modulation and demodulation
7. Implementation and analysis of BFSK modulation and demodulation
8. Implementation and analysis of BPSK modulation and demodulation. *(Through Virtual Lab)*
9. Implementation and analysis of QPSK modulation and demodulation. *(Through Virtual Lab)*
10. To simulate M-ary Phase shift keying technique using MATLAB.
11. To study generation and detection of DPSK using MATLAB.
12. Implementation and analysis of Delta modulation and demodulation.
13. Implementation and analysis of DSSS Modulation, Demodulation & BER measurement.
14. Implementation and analysis of FHSS Modulation, Demodulation & BER measurement.
15. To study encoding and decoding of Linear Block Codes
16. To study the working of Convolution encoder.

Part B

1. To study simple dipole $\lambda/2$ antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
2. To study folded dipole antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
3. To study $\lambda/2$ phase array end-fire antenna and to calculate beam-width, front / back ratio, and gain of the antenna.
4. To study broadside array antenna and to calculate beam-width, front / back ratio, and gain of the antenna.

Virtual Lab Link: <https://vlab.amrita.edu/?sub=1&brch=201>

Course Outcomes: At the end of this course students will demonstrate the ability:

1. To formulate basic concepts of pulse shaping in digital communication.
2. To identify different line coding techniques and demonstrate the concepts.
3. To design equipments related to digital modulation and demodulation schemes.
4. To analyze the performance of various digital communication systems and evaluate the key parameters.
5. To conceptualize error detection & correction using different coding schemes in digital communication.

BEC-652	CONTROL SYSTEM LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Introduction to MATLAB Control System Toolbox.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for given closed loop system in block diagram representation.
5. Create the state space model of a linear continuous system.
6. Determine the State Space representations of the given transfer function.
7. Determine the time response of the given system subjected to any arbitrary input.
8. Plot unit step response of given transfer function and find delay time, rise time, peak time, peakovershoot and settling time.
9. Determine the steady state errors of a given transfer function.
10. Plot root locus of given transfer function, locate closed loop poles for different values of k .
11. Plot bode plot of given transfer function. Also determine gain and phase margins.
12. Plot Nyquist plot for given transfer function. Also determine the relative stability by measuring gain and phase margin.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Classify different tools in MATLAB along with the basic matrix operations used in MATLAB.
2. Evaluate the poles and zeros on s-plane along with transfer function of a given system.
3. Construct state space model of a linear continuous system.
4. Evaluate the various specifications of time domain response of a given system.
5. Appraise the steady state error of a given transfer function.
6. Examine the relative stability of a given transfer function using various methods such as root locus, Bode plot and Nyquist plot.

BAC-653A	WIRELESS COMMUNICATIONS NETWORKS LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Write specifications of the latest desktops and laptops.
2. Familiarization with Networking Components and devices: LAN Adapters, Hubs, Switches, Routers etc.
3. Familiarization with Transmission media and Tools: Co-axial cable, UTP Cable, Crimping Tool, Connectors etc.
4. Preparing straight and cross cables
5. Study of various LAN topologies and their creation using network devices, cables and computers.
6. Configuration of TCP/IP Protocols in Windows and Linux.
7. Implementation of file and printer sharing.
8. Designing and implementing Class A, B, C Networks
9. Subnet planning and its implementation
10. Installation of ftp server and client.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand network communication using the layered concept, Open System Interconnect (OSI) and the TCP/IP Model.
2. Analyze the services and features of various protocol layers in the data link layer.
3. Demonstrate knowledge of multiple access to design an access technique for a particular application.
4. Understand the protocols at different layers of a network hierarchy.
5. Understand the principles and operations behind various application layer protocols like HTTP, SMTP, FTP.

BEC-653B	CAD (COMPUTER-AIDED DESIGN) FOR ELECTRONICS LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

Part A

PSPICE Experiments:

1. (a) Transient Analysis of BJT inverter using step input.(b) DC Analysis (VTC) of BJT inverter
2. (a) Transient Analysis of NMOS inverter using step input.
(b) Transient Analysis of NMOS inverter using pulse input.
(c) DC Analysis (VTC) of NMOS inverter.
3. (a) Analysis of CMOS inverter using step input.
(b) Transient Analysis of CMOS inverter using step input with parameters.
(c) Transient Analysis of CMOS inverter using pulse input.
(d) Transient Analysis of CMOS inverter using pulse input with parameters.
(e) DC Analysis (VTC) of CMOS inverter with and without parameters.
4. Transient & DC Analysis of NAND Gate using CMOS inverter.
5. Transient Analysis of NOR Gate inverter and implementation of XOR gate using NOR gate
6. To design and perform transient analysis of D latch using CMOS inverter.
7. To design and perform the transient analysis of SR latch circuit using CMOS inverter.
8. To design and perform the transient analysis of CMOS transmission gate.
9. Analysis of frequency response of Common Source amplifiers.
10. Analysis of frequency response of Source Follower amplifiers

Part B :

HDL (using VHDL **program module** & **verilog Module**)

VHDL PROGRAMS

1. Design and Simulation of Full Adder using VHDL **program module**
2. Design and Simulation of 4x1 MUX using VHDL **program module**
3. Design and Simulation of BCD to Excess-3 code using VHDL **program module**
4. Design and Simulation of 3 to 8 decoder using VHDL **program module**
5. Design and Simulation of JK Flip-flop using VHDL **program module**
6. Design and Simulation of CMOS Inverter using **verilog Module**

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Design and analyze the performance of different type of inverters.
2. Design and analyze the performance of the basic logic gates using CMOS inverter circuit.
3. Design and analyze the performance of the memory based digital circuits using CMOS inverter circuit.
4. Analyze the performance of the different configuration of MOS amplifier circuits.

BEC-653C	MICROCONTROLLERS AND SENSORS FOR IOT APPLICATIONS LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Write a program on Arduino/Raspberry Pi to upload various data of different sensors onto things peak cloud.
2. Write a program to create TCP server on Arduino/Raspberry Pi and respond with relevant data of sensor to TCP client when requested.
3. Analysis IoT Data Logging using Beagle Board.
4. Indoor Air Quality Analysis using ESP32 & Byte beam Cloud.
5. Collect sensor data from Arduino/ESP32 and Raspberry Pi and analysis onto MATLAB.
6. Analysis of ESP32 UART Communication and RS232 TTL serial communication.
7. Analysis of data received from multiple boards at a time. (Many to one mapping)
8. Perform LED Blinking operation using MSP 430 GPIOs.
9. Configure the PWM module of the MSP430FR5969 Launchpad to control the brightness of LED.
10. PWM based DC Motor Speed Control using MSP430 GPIOs.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Introduction to IoTs enabled technologies.
2. Analyze the mechanism of Data Acquisition and processing.
3. Understand data classification, process of big data technology, user roles and Detects myths in big data
4. Analyze software and management tools for Industrial applications of IoTs
5. Understand the Real-World design constraints and challenges.